

14149 - 232 grams - bottom
14148 - 85 grams - top
14156 - 162 grams - middle
 Trench Soils

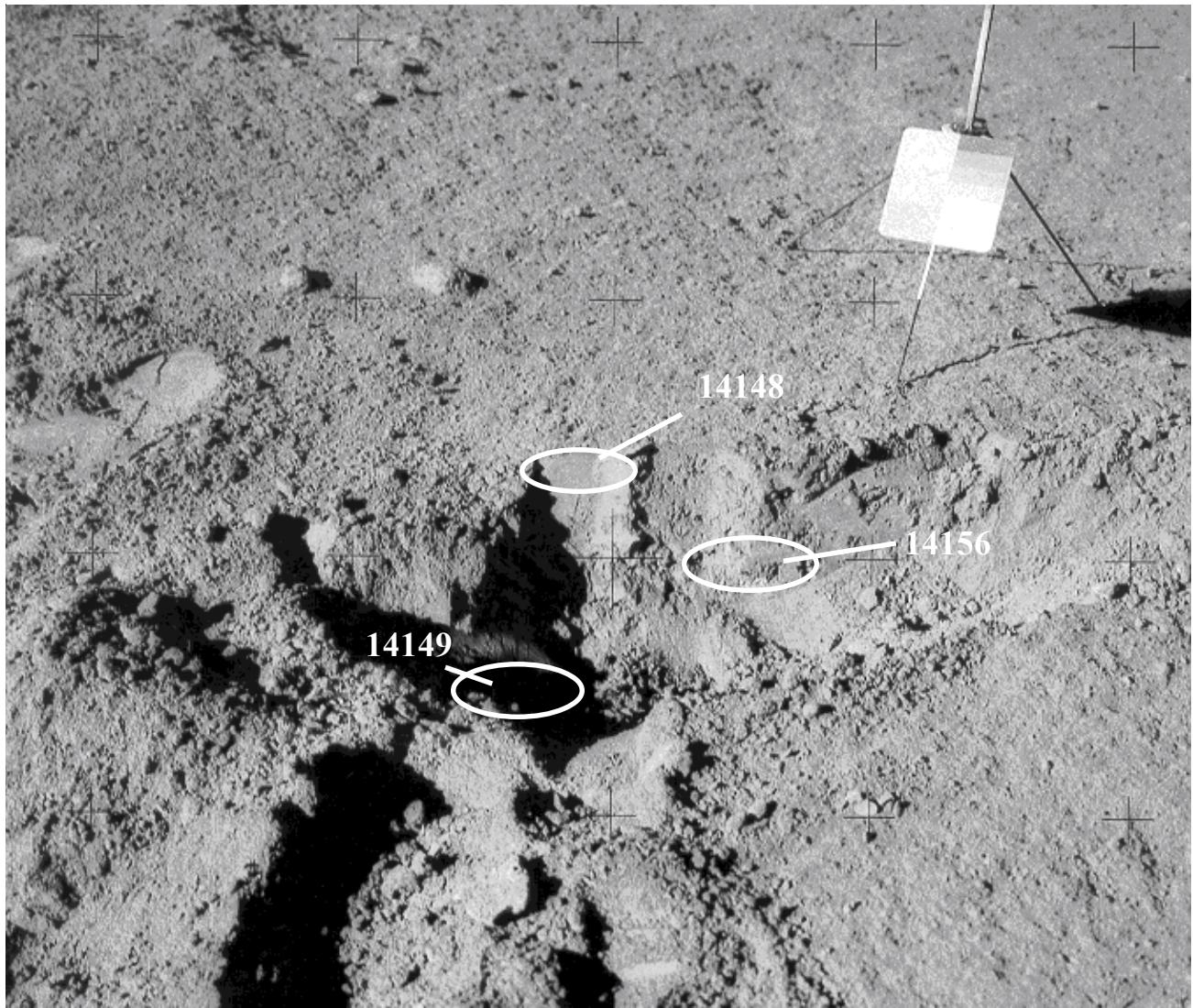


Figure 1: Soil Mechanics Trench at Apollo 14, Triple Crater. Note walls are not stable. AS14-64-9161. Gnomon legs are 50 cm apart. Trench is about 30 cm deep. SESC sample 14240 also collected from this trench.

Introduction

The Soil Mechanics Trench for Apollo 14 was planned for 60 cm depth, but Shepard found that the walls were caving in, so he discontinued digging at about 18 inches or 30 cm. Numerous samples were collected from this trench including 14149 and 14240 (SESC) which were taken from the bottom of the trench (Sharp Crater, station G). Sample 14148 is the soil from the surface and 14156 from about the middle of the trench wall

(figure 1). Samples 14145, 14080 and 14081, 14073 to 14079 are rock samples taken from the same trench. Sample 14149, 14148 and 14156 are less than 1 mm fines. When these soil samples were sieved, additional sample numbers were assigned to the coarse-fines (see diagrams). 14220 and 14230 are drive tube samples taken nearby.

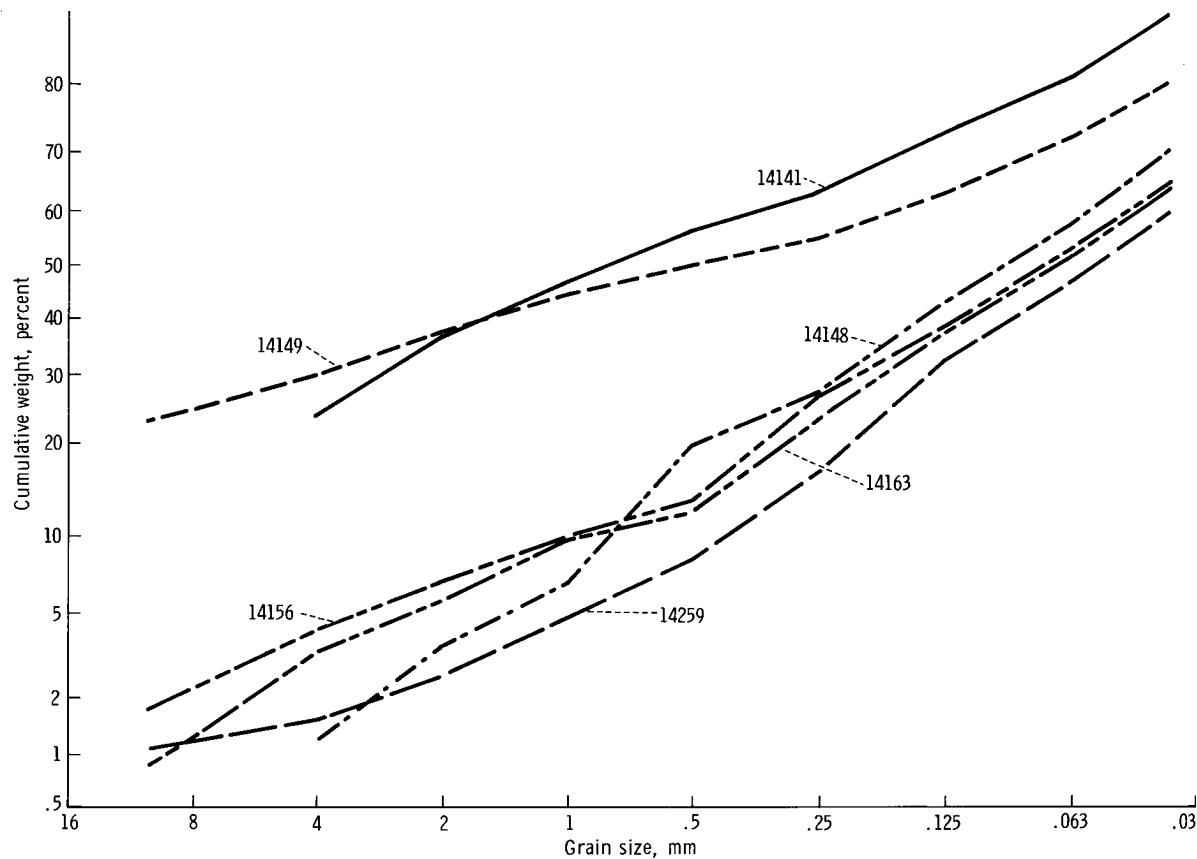


Figure 2: Grain size distribution for Apollo 14 soils showing the coarse grain size of the soil from the bottom of the trench (14149) and the rim of cone crater (14141) (from LSPET 1971).

The best description of the digging of the trench at station G is given in Mitchell et al. (1971). “*The site chosen for trenching was the western rim of a small crater approximately 6 m in diameter and 0.75 m deep.*” “*The CDR reported digging was easy and estimated his first cut to be a depth of approximately 15 cm with sidewalls at an angle of 70 to 80 degrees, but at that point they started caving in.*” “*The excavation passed through three distinct layers. The upper 3 to 5 cm were dark brown and fine grained. Next a very thin layer (0.5 cm thick or less) of black, glassy particles was encountered. Beneath this layer was a much lighter colored and coarser grained material.*”

Petrography

McKay et al. (1972) and Simon et al. (1982) showed that there was not much difference in the samples taken between the bottom and top of the trench (*however, LSPET 1971 and Mitchell et al. 1971 discuss a difference in grain size top to bottom, apparently based on data collected in PET, figure 2*). 14149 from the bottom had less agglutinates and was slightly less

mature (maturity index $\text{Is}/\text{FeO} = 53$) compared with 14148 from the top ($\text{Is}/\text{FeO} = 70$) or 14156 from the middle ($\text{Is}/\text{FeO} = 68$, Morris 1978). King et al. (1972) and Graf (1993) reported the size distribution of the three soils.

Chao et al. (1972), Nelen et al. (1972) and Glass et al. (1972) studied the glass beads in the three trench soils. 14156 was also one of the soils studied by the Apollo Soil Survey (see Reid et al. 1972a and b).

Chemistry

Lindstrom et al. (1972), Laul et al. (1982) and others determined the chemical composition of the soils from this trench (tables, figures 3 and 4).

Cadogen et al. (1972) give a nice discussion of carbon found in samples from this trench. (and correlation with track density)

Cosmogenic isotopes and exposure ages

Eldridge et al. (1972) and Keith et al. (1972) found slightly less ^{26}Al and ^{22}Na in the bottom sample of the trench (14149).

Other Studies

Basford et al. (1973) determined the isotopes of Xe and Kr. Nautiyal et al. (1981) and Venkatesan et al. (1980) studied the ^{22}Ne and Kr isotopes in 14148.

Bhandari et al. (1972), Hart et al. (1972), Berdot et al. (1972), Crozaz et al. (1972) and Bhai et al. (1978) studied the cosmic ray tracks in the grains of the trench, collectively finding that there was an order of magnitude less tracks in grains from the bottom of the trench (14149).

Processing

The samples from the bottom of this trench (14149 and 14240) may have been contaminated by surface material that fell into the trench during digging.

During Apollo 14, there was a very strange numbering system (see diagrams). It appears that all of each soil was sieved, leaving no unsieved “reserve” sample, as was the case in later missions. In addition to these sample, SESC sample 14240 was also collected from the bottom of this trench.

Modal content of soils 14148, 14156 and 14149.

90-150 micron fraction

From McKay et al. 1972.

	14148 trench top	14156 middle	14149 bottom
Agglutinates	50.2%	47.7	26.4
Basalt	2	6.4	
Breccia	28.8	23.4	35.2
Anorthosite			
Norite			
Gabbro			
Plagioclase	3	5.4	7.8
Pyroxene	3.2	5.6	11
Olivine	0.8	0.2	
Ilmenite	0.4	0.4	0.4
Glass other	11.4	17.2	12.8

Modal content of soils 14148 and 14149.

From Simon et al. 1982.

90 - 1000 micron

	14148 (top)	14149 (bottom)
Agglutinates	39.6 %	24.3
Basalt	0.6	3.1
Breccia		
	Dark	10.5
	Light	18.9
Anorthosite	0.9	0.4
Norite		
Gabbro		
Plagioclase	4.6	1.8
Pyroxene	6.5	6.6
Olivine		
Ilmenite	0.1	0.4
Glass other	12.7	8.4

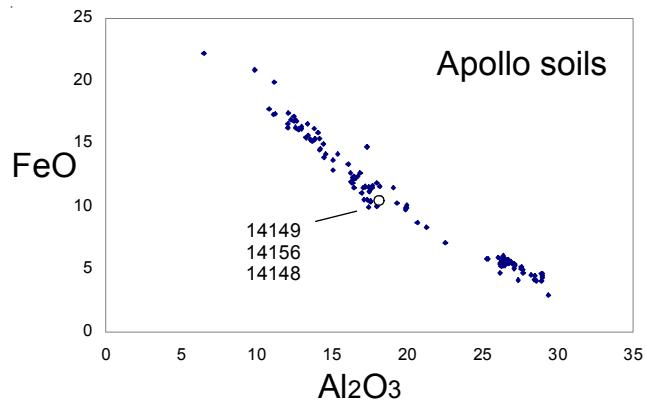


Figure 3: Chemical composition of Apollo 14 trench samples.

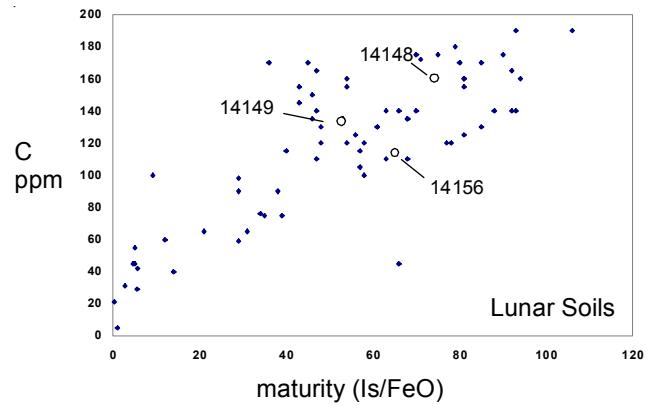
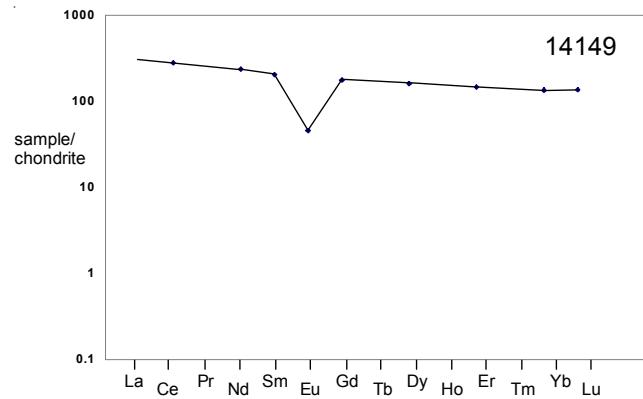
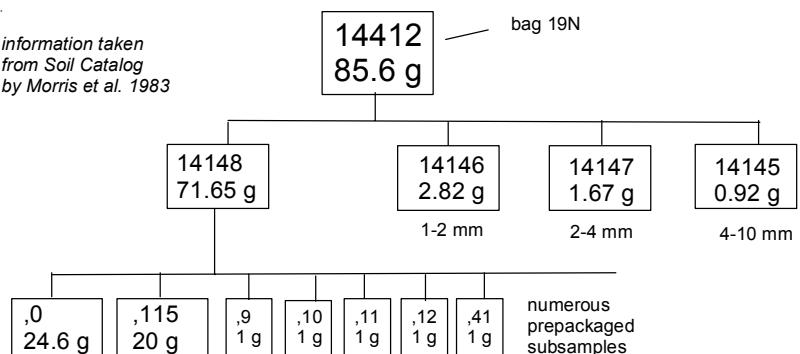


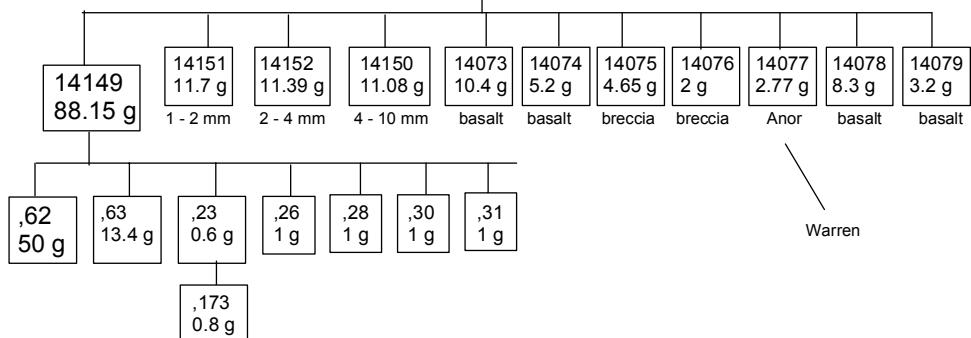
Figure 5: Carbon content and maturity from magnetic measurement

information taken
from Soil Catalog
by Morris et al. 1983



14408
232.1 g

bag 20N



C Meyer
2007

14409
162.3 g

sieved

bag 21N

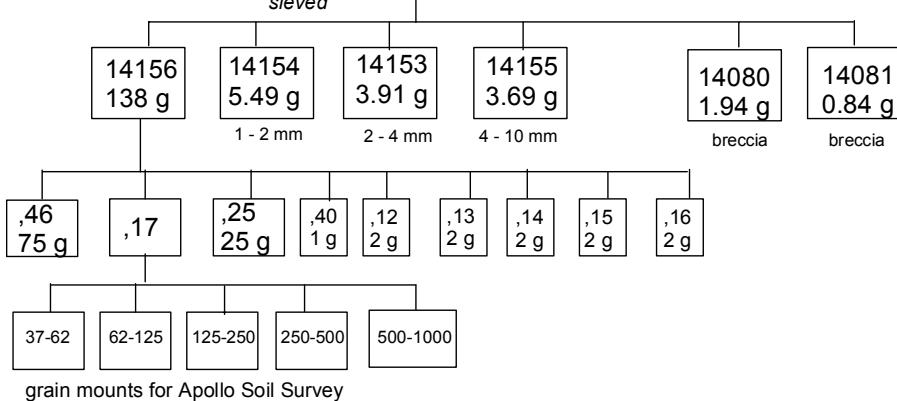


Table 1. Chemical composition of 14149.

reference weight	Lindstrom72	Philpotts72	Morgan72	Laul82	Murthy72	Eldridge72	Keith72
SiO ₂ %							
TiO ₂	1.55	(a)		1.6	(a)		
Al ₂ O ₃	17.3	(a)		17.9	(a)		
FeO	10.16	(a)		10	(a)		
MnO	0.117	(a)		0.13	(a)		
MgO				9.9	(a)		
CaO				11	(a)		
Na ₂ O	0.71	(a)		0.78	(a)		
K ₂ O	0.54	(a)	0.64	(b)	0.58	(a) 0.62	(b) 0.6
P ₂ O ₅						(d) 0.62	(d)
S %							
<i>sum</i>							
Sc ppm	20.5	(a)		21	(a)		
V				40	(a)		
Cr	1300	(a)		1232	(a)		
Co	40	(a)		27.5	(a)		
Ni				320	(a)		
Cu							
Zn			19	(c)			
Ga							
Ge ppb							
As							
Se			290	(c)			
Rb		14.5	(b)	13.9	(c)		
Sr		177.5	(b)		170	(a) 183.5	(b)
Y							
Zr	660	(a)	907	(b)	680	(a)	
Nb							
Mo							
Ru							
Rh							
Pd ppb							
Ag ppb			11.8	(c)			
Cd ppb			199	(c)			
In ppb							
Sn ppb							
Sb ppb			2.8	(c)			
Te ppb			15	(c)			
Cs ppm	0.66	(a)	827	(b)	0.6	(c)	
Ba	740	(a)	65.1	(a)	870	(a) 817	(b)
La	65.1	(a)			60.5	(a)	
Ce	177	(a)	169	(b)	170	(a)	
Pr							
Nd	100	(a)	108	(b)	110	(a)	
Sm	31.6	(a)	30.1	(b)	26.5	(a)	
Eu	2.76	(a)	2.56	(b)	2.2	(a)	
Gd			34.7	(b)			
Tb	6.7	(a)			5.4	(a)	
Dy			39.3	(b)	37	(a)	
Ho					8.2	(a)	
Er			23.4	(b)			
Tm					3.3	(a)	
Yb	21.7	(a)	22	(b)	20.2	(a)	
Lu	3.08	(a)	3.34	(b)	2.8	(a)	
Hf	23	(a)	20.8	(b)	21.9	(a)	
Ta	4.8	(a)			3	(a)	
W ppb							
Re ppb			1.05	(c)			
Os ppb							
Ir ppb			11.1	(c)			
Pt ppb							
Au ppb			7.5	(c)			
Th ppm	13.6	(a)			13.3	(a)	11.4
U ppm					3.6	(a)	3.2
						(d) 3.5	(d)

technique: (a) INAA, (b) IDMS, (c) RNNA, (d) radiation counting

Table 2. Chemical composition of 14148.

reference	Lindstrom72	Philpotts72	Morgan72	Laul82	Eldridge72	Keith72
weight						
SiO ₂ %						
TiO ₂	1.68	(a)		1.6	(a)	
Al ₂ O ₃	17.25	(a)		16.6	(a)	
FeO	10.3	(a)		12.2	(a)	
MnO	0.127	(a)		0.14	(a)	
MgO				9.9	(a)	
CaO				10.3	(a)	
Na ₂ O	0.68	(a)		0.74	(a)	
K ₂ O	0.5	(a)	0.54	(b)	0.53	(a)
P ₂ O ₅					0.53	(d)
S %					0.55	(d)
sum						
Sc ppm	21	(a)		25.5	(a)	
V	44	(a)		45	(a)	
Cr	1310	(a)		1437	(a)	
Co	34.4	(a)		39	(a)	
Ni				700	(a)	
Cu						
Zn			22	(c)		
Ga						
Ge ppb						
As						
Se						
Rb		14.8	(b)	16.8	(c)	
Sr		177.4	(b)		170	(a)
Y						
Zr	690	(a)	992	(b)		830
Nb						(a)
Mo						
Ru						
Rh						
Pd ppb						
Ag ppb				12.6	(c)	
Cd ppb				111	(c)	
In ppb						
Sn ppb						
Sb ppb				2.8	(c)	
Te ppb				25	(c)	
Cs ppm	0.4	(a)		0.695	(c)	
Ba	750	(a)	824	(b)		850
La	64.3	(a)				61
Ce	176	(a)	171	(b)		170
Pr						(a)
Nd	98	(a)	107	(b)		100
Sm	31.5	(a)	30.6	(b)		27
Eu	2.68	(a)	2.55	(b)		2.5
Gd			34.4	(b)		
Tb	6.6	(a)			6	(a)
Dy			38.9	(b)		38
Ho					9.2	(a)
Er			23.2	(b)		
Tm					3.3	(a)
Yb	21.7	(a)	21.6	(b)		20.2
Lu	3.18	(a)	3.31	(b)		2.85
Hf	25.7	(a)	20.6	(b)		26
Ta	4.7	(a)			3.3	(a)
W ppb						
Re ppb				1.34	(c)	
Os ppb						
Ir ppb				13.7	(c)	
Pt ppb						
Au ppb				6.9	(c)	
Th ppm	13.8	(a)			14	(a)
U ppm					3.5	(a)
					3.3	(d)
					3.7	(d)

technique: (a) INAA, (b) IDMS, (c) RNAA, (d) radiation counting

Table 3. Chemical composition of 14156.

reference	Lindstrom72	Philpotts72	Morgan72	Eldridge72	Keith72
<i>weight</i>					
SiO ₂ %					
TiO ₂	1.65	(a)			
Al ₂ O ₃	16.95	(a)			
FeO	10.42	(a)			
MnO	0.125	(a)			
MgO					
CaO					
Na ₂ O	0.68	(a)			
K ₂ O	0.52	(a)	0.54	(b)	0.57
P ₂ O ₅					0.52
S %					(d)
<i>sum</i>					
Sc ppm	20.9	(a)			
V	36	(a)			
Cr	1350	(a)			
Co	36.2	(a)			
Ni					
Cu					
Zn			20		(c)
Ga					
Ge ppb					
As					
Se			280		(c)
Rb		14.7	(b)	13.5	(c)
Sr		179.2	(b)		
Y					
Zr	700	(a)	913	(b)	
Nb					
Mo					
Ru					
Rh					
Pd ppb					
Ag ppb			11.7		(c)
Cd ppb			77		(c)
In ppb					
Sn ppb					
Sb ppb			3.6		(c)
Te ppb			25		(c)
Cs ppm	0.54	(a)			
Ba	780	(a)	813	(b)	
La	65.1	(a)			
Ce	175	(a)	169	(b)	
Pr					
Nd			107		(b)
Sm	31.4	(a)	29.9		(b)
Eu	2.66	(a)	2.57		(b)
Gd			34.9		(b)
Tb	6.6	(a)			
Dy			38.9		(b)
Ho					
Er			23.1		(b)
Tm					
Yb	21.5	(a)	21.8		(b)
Lu	3.05	(a)	3.27		(b)
Hf	23.2	(a)			
Ta	4.8	(a)			
W ppb					
Re ppb			1.11		(c)
Os ppb					
Ir ppb			12.7		(c)
Pt ppb					
Au ppb			5.3		(c)
Th ppm	13.8	(a)		11.9	(d)
U ppm				3.3	(d)
<i>technique:</i> (a) INAA, (b) IDMS, (c) RNAA, (d) radiation counting					

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